



CAGE POSITION STATEMENT ON THE USE OF POST-TENSIONED SLAB-ON-GROUND
FOUNDATIONS FOR SUPPORT OF RESIDENTIAL AND LIGHT COMMERCIAL BUILDINGS IN
THE COLORADO FRONT RANGE

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Post-tensioned slab-on-ground (PT slab) foundations have been used for support of residential and light commercial building structures along the Colorado Front Range since the early 1980's. Design of these systems has typically been based on design procedures developed by the Post-Tensioning Institute (PTI) as presented in their "Design and Construction of Post-Tensioned Slabs-on-Ground" manuals, First Edition dated 1980, Second Edition dated 1996, Third Edition dated 2004, and the 2008 Supplement to the Third Edition.

The design methodologies and procedures presented by PTI were developed based, in large part, on research performed at Texas A&M University, and on an earlier precursor to the PTI manuals, BRAB Report No. 33, dated 1968. The BRAB report (Building Research and Advisory Board, a Division of Engineering and Industry Research, National Research Council, National Academy of Sciences) addressed reinforced-stiffened slab foundations without post-tensioning. During the 1960's, the process of post-tensioning ground-supported slabs was developed, with initial installations located primarily in Louisiana and Texas.

The PTI soil input parameters are based largely on assumptions relating clay mineralogy and presumed subsurface moisture distributions to soil heaving potential. The PTI methods do not take into account direct measurements of a soil's swell-consolidation characteristics, which are routinely used for foundation design and estimates of potential ground heave in the Colorado Front Range. The PTI procedures also do not account for the influence of perched ground water conditions on soil moisture distributions. Local experience has demonstrated that the PTI procedures have sometimes not worked well on Colorado Front Range sites with high and very high swelling soil, particularly those with shallow claystone bedrock, if the prescriptive PTI procedures were strictly followed.

There is also reluctance on the part of many Colorado Front Range structural engineers to utilize the PTI procedures for design of PT slab foundations. That reluctance is based on similar concerns with the PTI development and complex mathematical expressions associated with the structural design aspects of the PTI procedures. Consequently, many structural engineering firms avoid designing PT slab foundations. As a result, the majority of Colorado Front Range PT slab designs have been performed by a relatively few structural engineers specializing in PT slab design.

Some members of the Colorado Front Range engineering community have expressed concerns regarding the local applicability of certain PTI procedures, generally during public forums or training sessions presented by PTI or local post-tensioning practitioners. To date, CAGE has not seen those concerns addressed in the PTI design manuals.

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Regardless of the concerns described above, the consensus of CAGE members is that the majority of PT slab foundations constructed on sites along the Colorado Front Range with low to moderate swelling soils at depths likely to influence slab performance have performed well. The incidence of foundation movement problems on high to very high swelling sites has been higher, particularly if proper site preparation techniques have not been implemented to mitigate heave. As a result of these experiences, the typical approach to PT slab design on high to very high swelling sites in the Colorado Front Range has evolved to mitigate the site swell potential in the zone of soil influencing shallow foundation performance by means of extensive site grading, to provide good drainage to reduce the potential for heave of the building foundations, and to cautiously implement the PTI design procedures using swell test data and judgment to correlate modified site swell potential to PTI input parameters.

The most common approach used locally for preparation of PT slab building sites with relatively high swell potential has been to remove the high to very high swelling material to some depth below the foundation and to modify or replace that material with moisture-treated, compacted fill. The experience of CAGE members is that, when these measures are properly implemented, there is a high success rate with use of PT slab foundations, despite the local concerns with the PTI design procedures.

It is the position of CAGE that PT slab-on-ground foundations have a long history of generally acceptable performance in the Colorado Front Range, and their continued use for certain types of structures is appropriate when accompanied by proper geotechnical site characterization, proper structural design, proper site preparation, proper construction, and proper management of water.

CAGE believes the merits of the PT slab system should be judged based on the past performance of similar foundations under similar conditions in the Colorado Front Range, rather than on the claim that PTI procedures cannot be used because they do not account for the behavior of expansive soils in Colorado.

As with any foundation type:

1. Movements of PT slab-on-ground foundations should be expected and, in certain instances, the magnitude of movement may result in problematic distortion and cosmetic distress.
2. The risk of excessive movement of PT slab-on-ground foundations can be mitigated by appropriate design of the building pad and the foundation by experienced and qualified geotechnical and structural engineers.
3. Adherence to a prescriptive design method for PT slab-on-ground foundations, while at the same time disregarding local experience and basic engineering principles, may significantly increase the risk of unacceptable performance.
4. The risk of excessive movements of PT slab foundations is increased if the geotechnical engineer's recommendations for proper site preparation, irrigation and surface and subsurface drainage are not followed.

CAGE does not believe there is any engineering basis for the assertion that PT slab foundations cannot be successfully used on Colorado Front Range sites just because PTI design procedures have not been fully reconciled with local geotechnical conditions and practices.

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